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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/879,428	06/12/2001	Henry A. Hill	09712-124001 / Z-288 Low	4098

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EXAMINER
ARTMAN, THOMAS R

ART UNIT	PAPER NUMBER
2882	

DATE MAILED: 01/16/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/879,428	HILL, HENRY A.
	Examiner	Art Unit
	Thomas R Artman	2882

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 June 2001* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-21* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *14-21* is/are allowed.

6)☒ Claim(s) *1 and 3-11* is/are rejected.

7)☒ Claim(s) *2, 12-13* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *12 June 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *4, 5* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Objections

Claims 2 and 12-13 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1 and 3-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Makinouchi (US 5,969,800) and in view of Hill (US 6,137,574).

Regarding claim 1, Makinouchi discloses a scanning exposure apparatus having a servo control system (Fig.3) having interferometers (Figs.1 and 2, items 7 and 14) that give positional information to the servo that corrects for any alignment deviation between the reticle and wafer compared to a desired position (col.3, lines 21-50). In Makinouchi's calculations, he shows a compensation method for taking measured positions of the reticle and wafer stages and comparing them to each other and to a predetermined position such that proper alignment can be maintained. The compensated speed signal (Fig.3, "ΔRX', ΔRL', ΔRR'") is generated based upon the measurements of the actual positions of the reticle and wafer stages. As one skilled in

the art would readily recognize, the positions are determined from phase data (interferometer outputs) that correspond to the positions of the stages.

Makinouchi does not specifically disclose a compensated position signal that is generated from the measured signal and a correction term that has a sinusoidal dependence upon the position of the measurement object.

Hill discloses a Fourier-based compensation method for correcting the measured phase relating to the position of a measurement object using a sinusoidal correction term that is dependent upon the measured phase (position signal) in Eq.1. Hill states that the compensation method can be used advantageously in any number of interferometric arrangements and applications to increase the accuracy of displacement measurements (col.8, lines 35-55), particularly for scanning or stepped mask exposure systems or beam writing lithography systems. It compensates for non-linear cyclic errors including beam mixing in heterodyne interferometers as well as multiple reflections, etc., that exist in a typical interferometer.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate Hill's analyzer for performing cyclic error phase compensation with Makinouchi's servo control system to improve the accuracy of the positional data Makinouchi's servo requires for proper exposure alignment compensation during operation.

With respect to claim 3, Makinouchi does not specifically disclose the practice of generating the compensation signal by subtracting a sinusoidal correction term from the interferometrically derived position signal. In the prior art combination of claim 1, Makinouchi's compensated speed signal is based upon the compensated position signal, and the

position signal is a function of the phase data, and therefore, a function of Hill's sinusoidal correction terms. As seen in col.12, Eq.4 of Hill, we see the sinusoidal correction term, Θ, subtracted from the measured phase in order to arrive at the compensated phase. This is a simple, straight forward application of applying error correction that is well known in the art. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to compensate for phase errors by subtracting the correction term from the measured phase to achieve a more correct phase measurement.

With respect to claims 4 and 5, Makinouchi does not specifically disclose the type of interferometer used for his stage metrology. Hill specifically states that his phase compensation method can be used with heterodyne signals and associated interferometers, such as the general type outlined in col.1, lines 18-43. The signals that Hill's method compensates are heterodyne signals with phase data based upon a heterodyne frequency. It would have been obvious to one of ordinary skill in the art at the time the invention was made to use a heterodyne interferometer for the well-known, precise measurement capabilities over homodyne systems for stage metrology, and therefore would also be obvious to apply Hill's phase compensation method since it specifically addresses non-linear cyclic errors common in heterodyne systems.

In regards to claims 6-7, Hill's sinusoidal correction term, Θ, has multiple sinusoidal terms. This is a standard Fourier analysis, where cyclic errors are best-fit as sine and cosine series. Hill's method compensates for the common, resolution limiting cyclic errors that occur in heterodyne interferometers that are commonly used in the art for displacement measurements. It

would have been obvious to one of ordinary skill in the art at the time the invention was made to have multiple sinusoidal terms in the correction term because such a parameterization provides convenient, well-known methods for fast data analysis, such as fast Fourier Transform techniques, etc., and it would also have been obvious to provide a sinusoidal correction term to account for cyclic errors since this practice will improve the accuracy of the measured position data.

With respect to claims 8-9, Makinouchi specifically discloses his servo control positioning system for use with a lithography tool. Futher, Hill states in col.8, lines 53-55, that his correction method is useful with displacement interferometer systems that are used in conjunction with lithography tools and beam writing tools. As feature sizes become smaller in micro and nano fabrication, the precise positioning of reticle and wafer stages, in a lithography tool, for example, require precision positioning that is limited by the errors that occur in interferometric metrology systems. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use this error compensated method with a servo metrology control system for improved accuracy in micro and nano fabrication applications.

Regarding claim 10, it would have been obvious to one of ordinary skill in the art at the time the invention was made that the prior art combination of Makinouchi and Hill applied above against claim 1 would satisfy the limitations set forth, including having:

1) an input port configured to receive a position signal from an interferometry system indicative of a position for the measurement object,

2) a memory storing a representation of non-linear errors in the interferometry system,

3) a processor which during operation generates a compensated position signal based on the position signal from the interferometry system and the stored representation, and

4) an output port configured to direct the compensated position signal to a servo-controller.

With respect to claim 11, it would have been obvious to one of ordinary skill in the art at the time the invention was made that the structure as applied above against claim 6 would satisfy the limitations set forth, wherein the stored representation of non-linear errors can be expressed as a sum of multiple correction terms each having a sinusoidal dependence on the position of the measurement object.

Allowable Subject Matter

The following is a statement of reasons for the indication of allowable subject matter:

Regarding claim 2, the prior art made of record does not reasonably teach the combination of determining a speed of the measurement object based upon an interferometrically derived position signal, and selecting parameters for a sinusoidal correction term based upon the determined speed.

Regarding claim 12, the prior art made of record does not reasonably teach the additional practice of parameterizing non-linear errors by the speed of the measurement object.

Claim 13 is dependent upon the allowable subject matter of claim 12.

Claims 14-21 are allowed.

The following is an examiner's statement of reasons for allowance:

Regarding claim 14, the prior art made of record does not reasonably teach the combined practice of translating the measurement object at a fixed speed while identifying frequencies of any oscillations in the position of the measurement object at the fixed speed and determining amplitude and phase coefficients for a sinusoidal correction term for at least one of the identified frequencies for suppressing the oscillations at that frequency.

Claims 15-21 are dependent upon the allowed claim 14, and are therefore allowable.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Hines (Jet Propulsion Lab., CIT) teaches the practice of identifying frequencies of nonlinearities in measurement object positions; Abrams (US 4,413,908) discloses an electronic method for measurement object position servo control.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thomas R Artman whose telephone number is (703) 305-0203. The examiner can normally be reached on 8am - 5:30pm Monday - Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Robert Kim can be reached on (703) 305-3492. The fax phone numbers for the

organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-1782.

TRA
January 10, 2003